**Project Title:**
Quantifying the effect of bag perforations on forced-air cooling cycles and post storage quality of apples.

**Researcher:** Daniël Viljoen  
Contact details: Daniel@experico.co.za

**Objectives and Rationale**

The pome industry is under pressure to reduce the forced-air cooling (FAC) cycle time of commercial pallets after packing and prior to shipment. It is likely that the forced-air cycles can be shortened if perforated liner bags are used in place of the non-perforated bags typically used as standard for apples.

**Objectives:**
1. To quantify the improvement in cooling rates/shorter forced-air cooling cycles for apples packed in perforated bags.
2. To determine the ability of liner bags, perforated to the extent that a significant reduction (>20% - 40%) in forced-air cooling (FAC) rates is achieved, can still maintain post storage quality during simulated export of apples.

**Methods**

Each season, three populations of fruit that had been cold stored in bins under controlled atmosphere were packed into bags with small perforations and bags with large perforations and subjected to FAC. Fruit stored in standard non-perforated bags served as controls. After cooling, fruit were stored for 5 and 9 weeks in regular atmosphere (RA). Cultivars used in this trial were Granny Smith, Top Red, Cripps’ Pink, Golden Delicious, Fuji and Braeburn.

**Key Results**

2016  
High levels of superficial scald were detected on the ‘Granny Smith’ apples tested. However, no trend could be observed relating to a specific treatment. Fruit in bags with small and large perforations had a shorter 90% cooling rate compared to fruit in non-perforated bags.

2017  
High lenticel spot incidence occurred on ‘Golden Delicious’ apples packed without bags and in perforated bags, while this problem was less pronounced on apples in non-perforated bags.

2018  
Large perforations resulted in FAC times decreasing by more than 40%. Marginal differences were detected regarding lenticel related defects on fruit stored in bags with different perforation dimensions.

**Conclusion and Discussion**

2016  
Marginal differences in post storage quality occurred between ‘Granny Smith’ apples stored in regular non-perforated bags, no bags, and fruit stored in bags with small and large perforations. A decrease in FAC time occurred for fruit stored without bags, or in bags with small and large perforations, compared to fruit stored in non-perforated bags.

2017  
Fruit packed in bags with small perforations did not cool as efficiently as was the case with large perforations. With Reds and ‘Cripps’ Pink’ apples, the shorter cooling time had no
significant negative effect on fruit quality, ‘Golden Delicious’ apples exhibited significantly more lenticel damage when packed and forced-air cooled in perforated bags or without bags, compared to the standard non-perforated bag.

2018
Packing fruit in bags with large perforations resulted in more efficient FAC. No differences were noted regarding fruit quality between the different bag treatments. Bag liners with large perforations enabled 30-45% shorter cooling times depending on carton type, while bags with small perforations resulted in 5-20% shorter cooling times. Care should be taken with sensitive cultivars such as Golden Delicious which developed lenticel related disorders after being forced-air cooled without a plastic bag liner, or in perforated liner bags. Further trials should be conducted to understand the factors causing this disorder and to develop a strategy to lower the risk of it developing during shipping.